



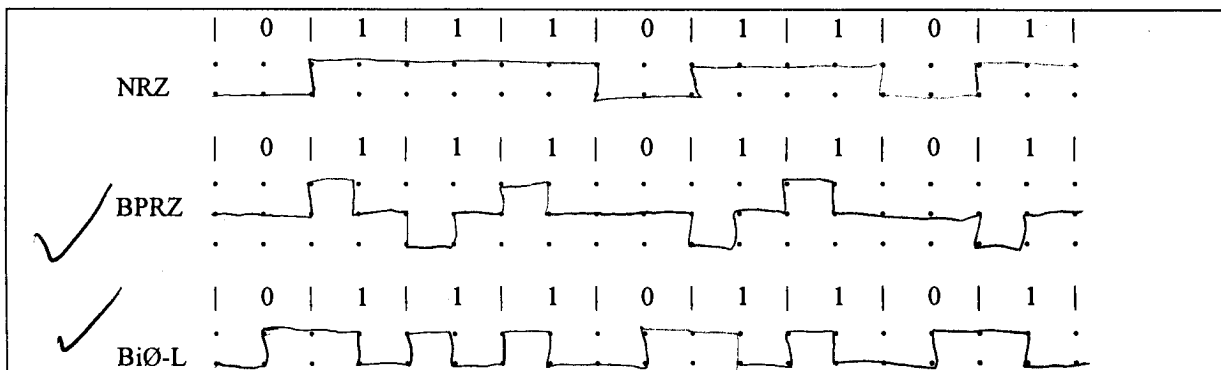
Time: 25 minutes

Permitted: - text, printed notes, student's own *hand-written* materials
Use the space below each question for your answer.

5

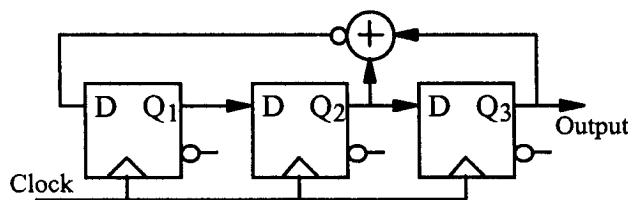
 $\frac{7}{10}$

- 1 Illustrate non-return to zero (NRZ), bipolar return to zero (BPRZ) and Manchester (biphase-level) coding for the following binary sequence (2 pts)



- *2 A three-stage shift register is connected to produce a pseudorandom binary sequence (PRBS). This is also known as a maximal length (ML) or pseudonoise (PN) sequence. Assume that the registers start in the all zero state (000) and that the output voltage levels are ± 2 volts. The clock frequency is 7 MHz (3 pts)

- What is the length and bit pattern of the output sequence? How often does the sequence repeat?
- Sketch the two-sided spectrum (Fourier series) of the output. Calibrate the frequency and amplitude scales in your illustration and include units.
- Calculate the power in the time domain. Consider Parseval's Theorem and estimate the power in the frequency domain up to the first spectral null.

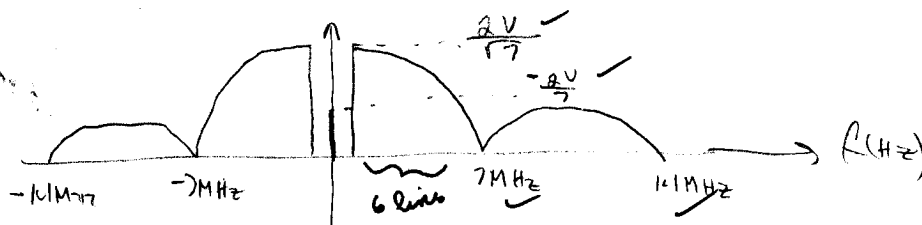


$$1) 2^3 - 1 = 8 - 1 = 7 \quad \checkmark$$

$$\text{if } \text{CLK} = 7 \text{ MHz} \quad T = \frac{1}{7 \text{ MHz}} = 142.85 \text{ ns}$$

$$7T = 1 \mu\text{s} \quad \text{repeat every } 1 \mu\text{s} \quad \checkmark$$

0	0	0	0
1	0	0	0
1	1	0	0
0	1	1	1
1	0	1	1
0	1	0	0
0	0	1	1



iii) power is 1.42857 mW with amplitude 2V

- *3 a) Complete the table below for digital transmission signals used in North America. (1 pt)

	DS1	DS1-C	DS3	STS-1
Number of voice signals	24 ✓	48 ✓	672	672
Transmission bit rate (Mb/s)	1.544	3.152	44.736 ✓	51.84 ✓
Number of bits per Multiframe (or STS-1 frame)	3316 ✓	1272	4760	6480 ✓
Duration of the Multiframe (us)	1500	103.6 ✓	106.4	125
Number of framing bits per Multiframe (or STS-1 frame)	12 ✓	12	31	16 ✓
Checksum (truncated)	3853	1738	5614	7344

- b) What is the probability that a given 16 bits of random data will resemble the STS-1 framing word? What is the probability that this pattern will occur at least once within the "random" data (or other overhead) portions of a 125 us STS-1 frame? (1 pt)

$$a) P = 1 - (1 - 2^{-16})^{513} = 7.7 \times 10^{-3}$$

$$b) P_{FA} = 2^{-16} = 1.526 \times 10^{-6}$$

Bad Wording

- *4 A transversal filter is constructed from a binary shift register with 16 taps. The transversal filter is arranged to generate an approximation to a single $\sin \pi f_b t / \pi f_b t$ pulse truncated at $t = 2/f_b$ where the bit rate $f_b = 100$ kb/s. The clock rate of the shift register is 4 times the bit rate thus each sidelobe of the time response has 4 samples and the main lobe has 8 samples. The peak voltage of the transmitted pulse is 4 volts. (3 pts)

- On scales below, sketch the time response of the filter output (i.e. the approximation).
- On a two-sided calibrated frequency axis, sketch the spectrum of the transmitted signal if the $\sin \pi f_b t / \pi f_b t$ pulse were not truncated.
- Approximately sketch the spectrum of the truncated transmitted pulse. Note that the transmitted pulse can be modeled as the product of a single $\sin \pi f_b t / \pi f_b t$ pulse and a gating pulse and that the resulting spectrum is the convolution of the two spectra in the product.

